Sub-laser-cycle electron pulses for probing molecular dynamics

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Lasers cannot rival synchrotrons for producing short wavelength (~1 Å) photons, but they make 1 Å or less wavelength electrons very easily during strong field ionization of atoms and molecules. Allowing for only single ionization, a newly formed ion experiences a current density due to the electron being pushed back to the ion by the oscillating field. I will describe using a "molecular clock" based on a vibrational wavepacket in H_2^+, to measure that the magnitude and time structure of the current density of the main electron pulse is ~ $8x10^{10}$ amps/cm^2 and lasts ~ 1 femtosecond. These electrons, made where and when they are needed, offer a new approach to molecular imaging using electron diffraction or inelastic scattering.